Ministry of
Transportation and
Communications

Ontario

MI-113

# AN EVALUATION OF ABRASIVE BLASTING MATERIALS

MATERIALS INFORMATION
ENGINEERING MATERIALS OFFICE

# AN EVALUATION OF ABRASIVE BLASTING MATERIALS

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CONCRETE SECTION

JANUARY 1988

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**SUMMARY**

Five blastcleaning abrasives including both natural and manufactured materials were field evaluated to determine their effectiveness in cleaning the surface of concrete and corroding reinforcing steel. Two 1986 Central Region rehabilitation contracts were selected for this evaluation. Contract 85-74 contained a structure that was built in 1969 with air entrained concrete and deformed reinforcing steel bars. The other contract selected, 85-76 included rehabilitation of an older structure that was built in 1927. The concrete in this structure was non air entrained and contained plain or non deformed reinforcing steel.

**INTRODUCTION**

Ontario Provincial Standard Specification 1004 was under review in 1986. Sub section 1004.05.02 specified that abrasives for sandblasting shall consist of silica grains that are subangular to round in shape. This was acceptable to committee members concerned with abrasive blasting prior to waterproofing where only a thorough cleaning was required and for structural steel blasting where acceptance is based on an anchor pattern. Silica was also the only approved material for abrasive blasting in OPSS 930 - Construction Specification for Concrete Overlays.

Recently environmental concerns have been responsible for limitations in the use of silica in some areas of the Province. In fact its use may be prohibited entirely in the near future. The OPSS committee for 1004 therefore recommended that field trials be conducted to evaluate other abrasives that were readily available. It was also proposed that a specified finish be established for existing exposed reinforcing steel was well as for areas of concrete where scarification or removal had been completed.

**FIELD TRIALS**

In order to achieve a reasonably accurate comparison of the effectiveness of the selected abrasives (Table I) it was important that operating equipment, i.e. compressor, airhose and nozzle were the same. The air compressor had a capacity of 5 m3/min. the hose 40 mm I.D. and the nozzle used was a #6. The pressure at the nozzle was 620 KPa. The operator was also instructed to hold the nozzle at approximately the same height and angle for each abrasive. Each of the selected bridge decks noted in the summary had been scarified prior to concrete removal. This surface texture has been found to be the most difficult to clean by abrasive blasting due to the pockets of hardened slurry remaining after the scarifying operation. Chipping in delaminated and spalled areas had been completed so areas of exposed reinforcing steel were available close to the previously marked out areas of concrete.

Based on the abrasive supplier's recommendations, enough of each material was ordered to clean approximately 1 m2 of concrete surface and 2 m of reinforcing steel. In some cases the quantity supplied was insufficient and a complete cleaning of the rebars was not possible. However, enough material was available to assess its effectiveness. The physical properties of each material tested are given in Table II. The partical strength given in the Table is the subjective opinion of the Ministry's Petrographer.

Silica sand was used as the control abrasive on both of the contracts. Its performance in the past has produced the desired degree of cleanliness on both reinforcing steel and concrete. The performance of the other materials in this evaluation is not well documented by M.T.C.

The first material used was silica (Pages 8, 9, 19 and 20). Three passes were made by the operator on the reinforcing steel to produce the required finish, i.e. removal of all scale and corrosion deposits, in accordance with OPSS 930.07.02.06. The same number of passes were used on the concrete surface, and, as with the reinforcing steel the required cleanliness was achieved, i.e. removal of dirt, and a clean exposed aggregate condition. (Pages 8 and 19). At this time it was decided to make the same number of passes with the other four materials and compare the results. If sufficient abrasive remained, additional cleaning could be done, if required.

## EVALUATIONS

### FAYALITE SLAG

Fayalite slag is a black, angular, glass by-product of the copper refining process. It is approximately equal in cost to silica sand. After three passes by the operator the appearance of the plain reinforcing steel was classed as good, some pockets of corrosion remained in pits but the remainder of the rebar was clean (Page 11). On the deformed rebar the surface corrosion was removed, but some mill scale remained (Page 22). Two additional passes were required to achieve the near white finish obtained with silica. On the scarified concrete surfaces, this material produced excellent results with only three passes required to achieve a thorough cleaning (Pages 10 and 21). One advantage of using a black abrasive is that cleanup after completion of work is easier due to the contrast in colour of the abrasive and the concrete.

### NEPHALINE SYENITE

This abrasive is a combination of Albite and Microcline Feldspars with approximately 15% nephaline. It is primarily white in colour and as with Fayalite slag is close to Silica Sand in cost. Its performance on both deformed and nondeformed bars was classed as only fair after the three passes (Pages 13 and 24). Three more passes were required to obtain acceptable cleanliness of the rebars. On the concrete surfaces it performed somewhat better, however, some pockets of hardened slurry (Pages 12 and 23) remained after the initial cleaning. It should be noted that Nephaline Syenite is the softest of all the abrasives evaluated (Table II) which would account somewhat for its performance on reinforcing steel.

### OLIVINE

A light green mineral (Forsterite), Olivine is by far the most expensive abrasive used in the evaluations (Table II). On the older structure its performance was excellent on both reinforcing steel and concrete, with the results after three passes comparable to silica (Pages 14 and 15). However, on the newer structure, for unknown reasons, only fair results were achieved on the deformed reinforcing steel (Page 26). Insufficient quantities of the

abrasive prevented further passes, therefore, a complete assessment could not be made. The olivine performed well on the concrete surface of the newer structure providing a clean sound surface. Olivine is a very dense material, having a specific gravity of 3.4. This would mean that there would be fewer grains per tonne and more abrasive would be required to do the work. Combined with its higher cost this would probably preclude its use on most structural work.

**BOILER SLAG**

Boiler slag is a by-product of the steel refining industry and is readily available in most parts of Ontario. It has a black shiny appearance which is helpful in cleanup operations. This abrasive has been used on several ministry rehabilitation contracts with good results. On each of the structures in this evaluation its performance closely paralleled that of silica sand on both concrete and steel, although an additional pass was required on the rebars. (Pages 16, 17, 27 and 28).

**CONCLUSIONS**

On the basis of the evaluations contained in this report, the following conclusions are drawn:

1. Silica Sand produced the required degree of cleanliness on both reinforcing steel and scarified concrete in the shortest time and using the least amount of abrasives of all the materials evaluated.

2. All of the abrasives will clean concrete and reinforcing steel to the specified requirements of OPSS 930. However, Fayalite Slag, Nepheline Syenite and Olivine require more material to produce these requirements and subsequently would be more expensive.

3. No discernable difference was observed in the amount of dust produced by each of these abrasives when cleaning concrete. Precautions used for abrasive blasting with silica sand must also be required for all other abrasives.

**RECOMMENDATIONS**

It is recommended that any of the abrasives evaluated in this report can be used on Ministry structural projects.

It was decided at a sub-committee meeting on OPSS 1004 held soon after this evaluation was completed that the term sandblasting be revised to abrasive blasting wherever it is noted in OPSS Standard Specifications.

**FIELD APPRAISAL**

**50 YEAR OLD BRIDGE (PLAIN REINFORCING)**

Page 7 - Typical blasting position

Pages 8 through 17 - Top picture shows existing condition of either reinforcing steel or concrete.

- Bottom picture shows condition of steel or concrete after three passes with abrasive. The abrasive used is noted on each picture.

**15 YEAR OLD BRIDGE (DEFORMED REINFORCING)**

Page 18 - Top picture shows layout of areas of steel and concrete to be blasted.

Bottom picture shows typical blasting position.

Pages 19 through 28 - Top picture shows existing condition of either reinforcing steel or concrete.

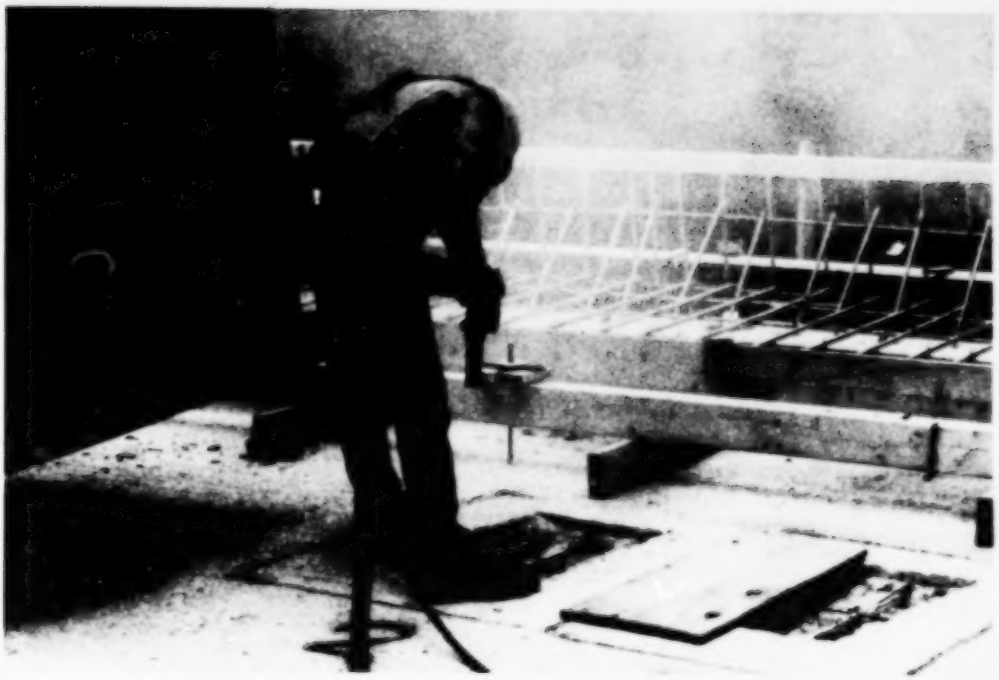
- Bottom picture shows condition of steel or concrete after three passes with abrasive. The abrasive used is noted on each picture.

| GENERIC NAME | TRADE NAME | SIZE | APPROXIMATE COST | FIELD APPRAISAL | | | |
|---|---|---|---|---|---|---|---|
| | | | | PLAIN REBAR | 50 YEAR OLD CONCRETE | DEFORMED REBAR | 15 YEAR OLD CONCRETE |
| SILICA SAND | SILICA | 40 (425 um) | $70/TONNE | EXCELLENT | EXCELLENT | EXCELLENT | EXCELLENT |
| FAYALITE SLAG | EBONY GRIT | 20 (1 mm) | $70/TONNE | GOOD | EXCELLENT | FAIR | EXCELLENT |
| NEPHELINE SYENITE | WHITE LIGHTNING | 10 - 40 (2 mm-425 um) | $80/TONNE | FAIR | GOOD | FAIR | GOOD |
| OLIVENE | GREEN LIGHTNING | 40 (425 um) | $154/TONNE | EXCELLENT | EXCELLENT | FAIR | GOOD |
| BOILER SLAG | BLACK BEAUTY | 20 - 40 (1 mm-425 um) | $100/TONNE | GOOD | EXCELLENT | EXCELLENT | EXCELLENT |

TABLE I

| GENERIC NAME | MOH'S HARDNESS | SHAPE | S.G. | PARTICLE STRENGTH |
|---|---|---|---|---|
| SILICA (QUARTZ) | 7 | SUB ANGULAR TO ROUNDED | 2.65 | STRONG |
| FAYALITE SLAG (GLASS) | 6.5 - 7.5 | ANGULAR | 2.85 | BRITTLE |
| NEPHELINE SYENITE (FELDSPARS & NEPHELINE | 5.5 - 6.0 | ANGULAR | 2.61 | BRITTLE |
| OLIVINE (FORSTERITE) | 6.5 - 7 | ANGULAR | 3.2 - 3.4 | BRITTLE |
| BOILER SLAG (GLASS) | 7 - 7½ | ANGULAR | 2.8 | BRITTLE |

TABLE II



TYPICAL BLASTING POSITION

EXISTING CONDITION

AFTER ABRASIVE BLASTING

EXISTING CONDITION

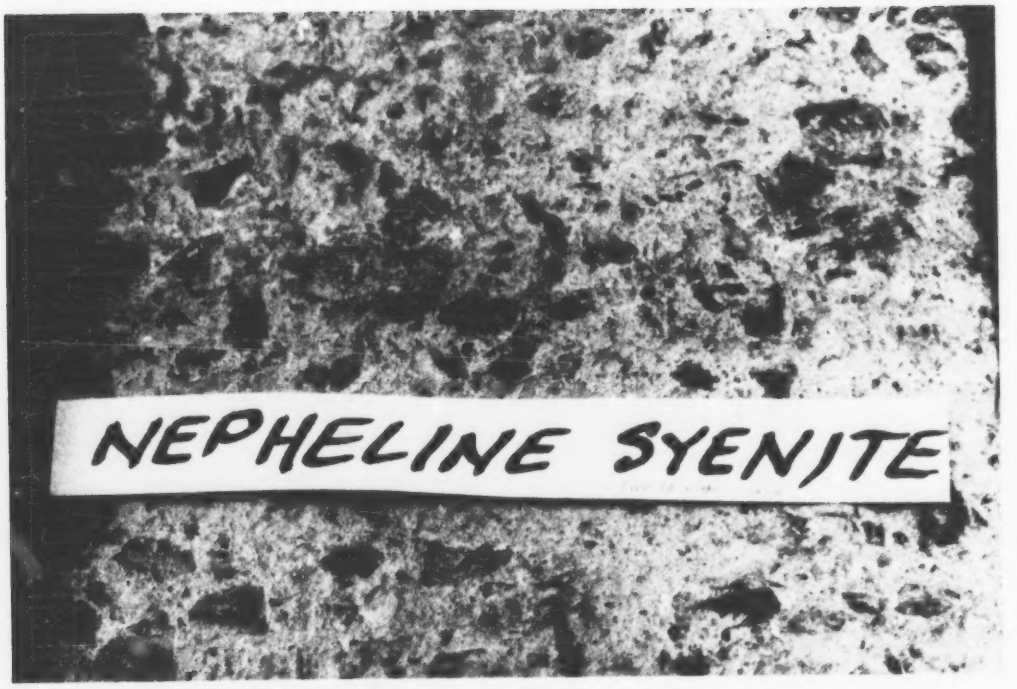
AFTER ABRASIVE BLASTING

EXISTING CONDITION

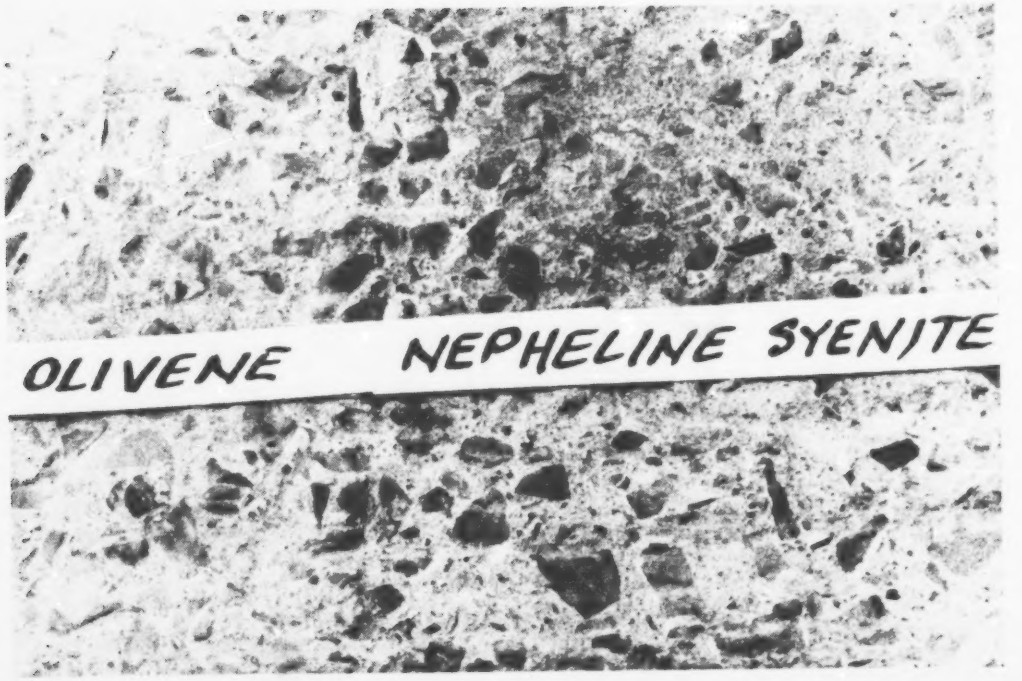
AFTER ABRASIVE BLASTING

EXISTING CONDITION

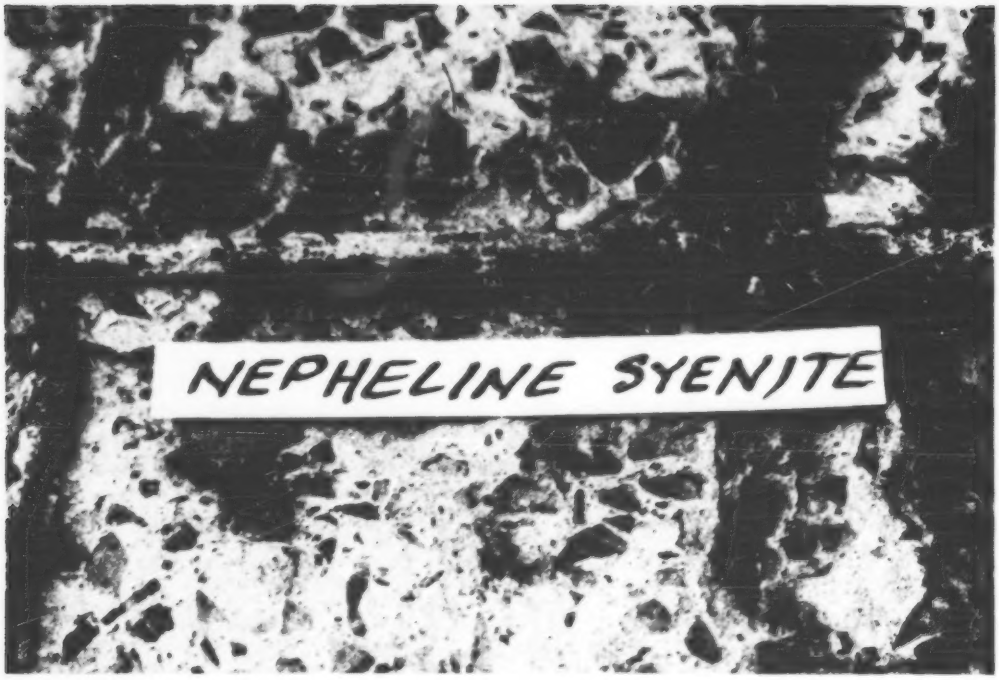
AFTER ABRASIVE BLASTING




EXISTING CONDITION




AFTER ABRASIVE BLASTING



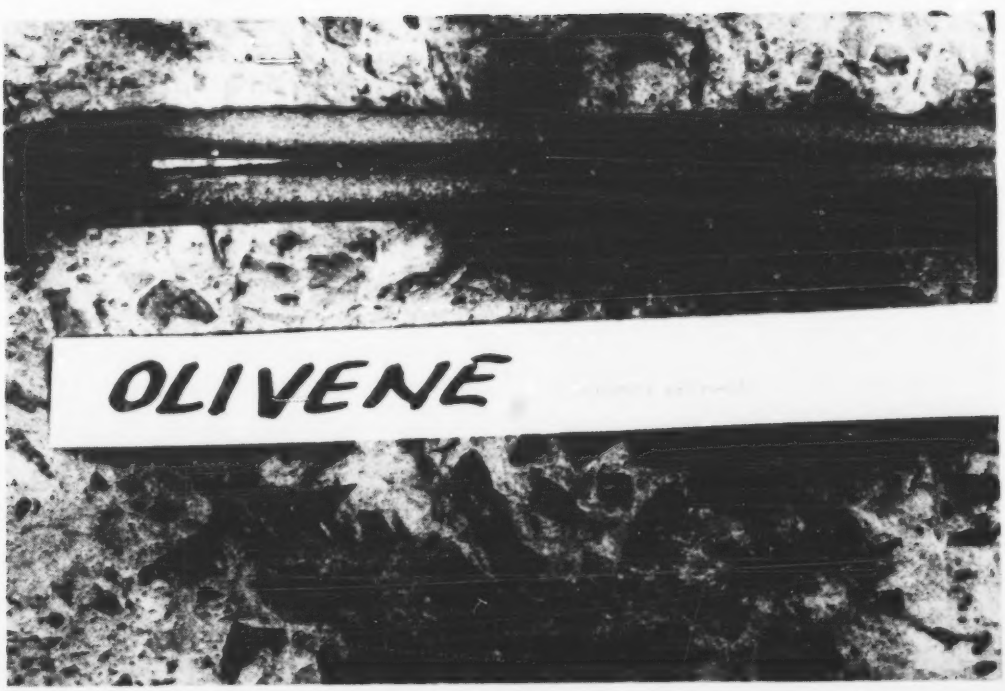

EXISTING CONDITION

AFTER ABRASIVE BLASTING

EXISTING CONDITION

AFTER ABRASIVE BLASTING

EXISTING CONDITION



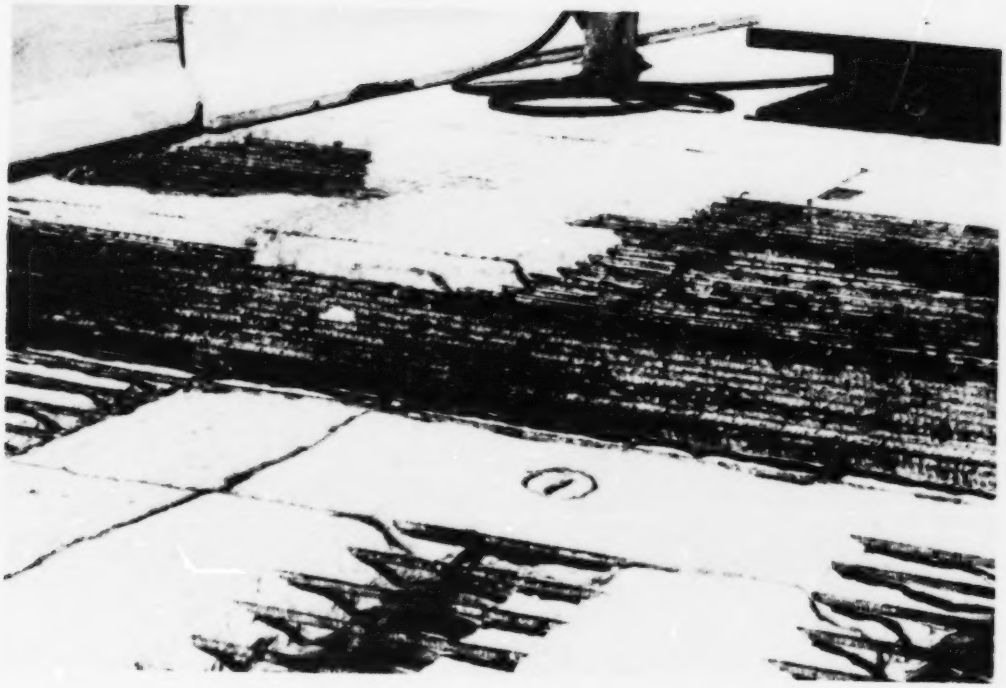

AFTER ABRASIVE BLASTING

EXISTING CONDITION

AFTER ABRASIVE BLASTING

EXISTING CONDITION

AFTER ABRASIVE BLASTING

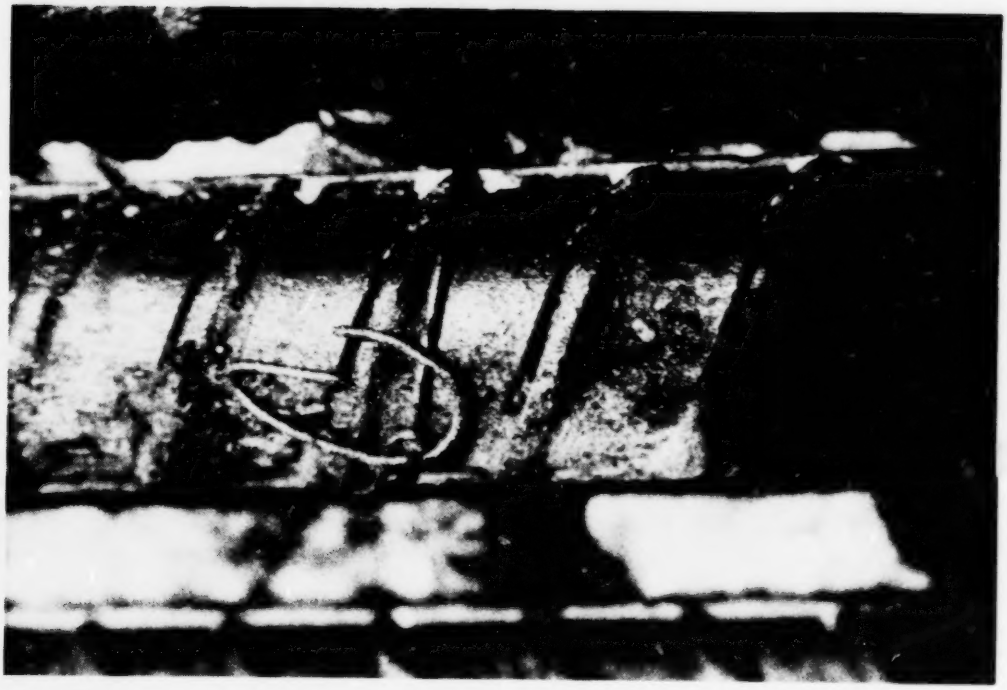


TEST AREA SHOWING SCARIFIED CONCRETE
SURFACE AND EXPOSED REINFORCING STEEL

TYPICAL BLASTING POSITION

EXISTING CONDITION

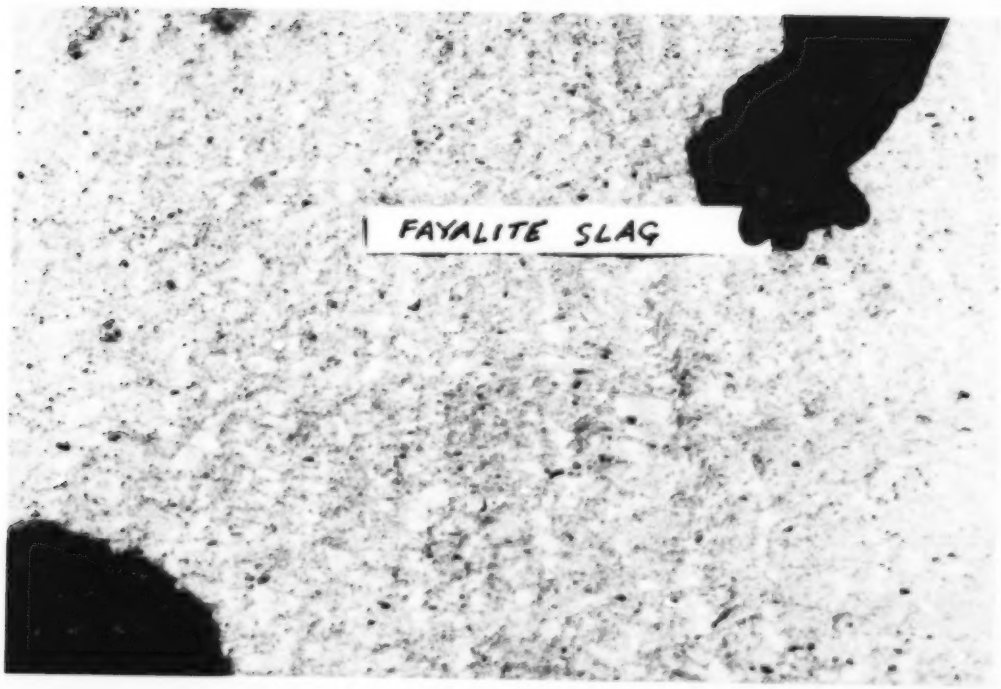
AFTER ABRASIVE BLASTING



EXISTING CONDITION

AFTER ABRASIVE BLASTING

EXISTING CONDITION

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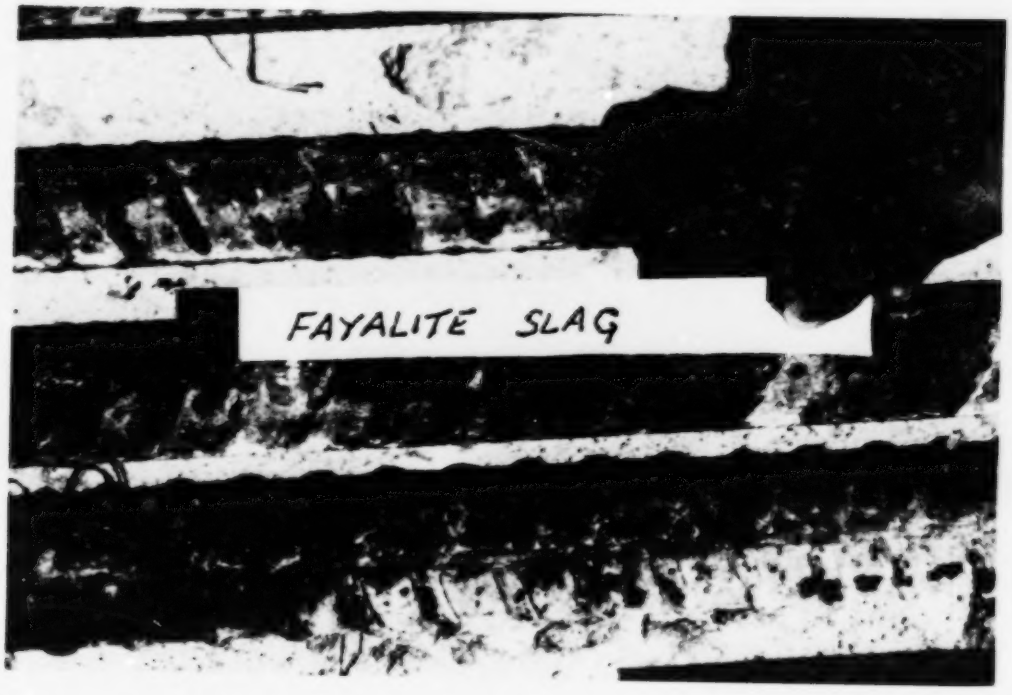
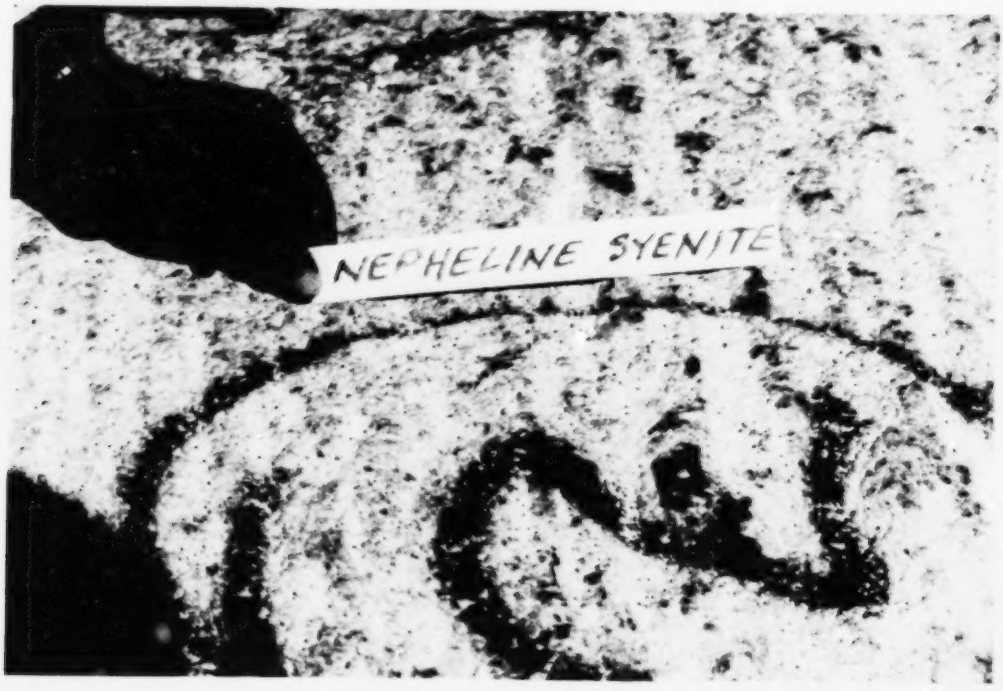



EXISTING CONDITION

AFTER ABRASIVE BLASTING

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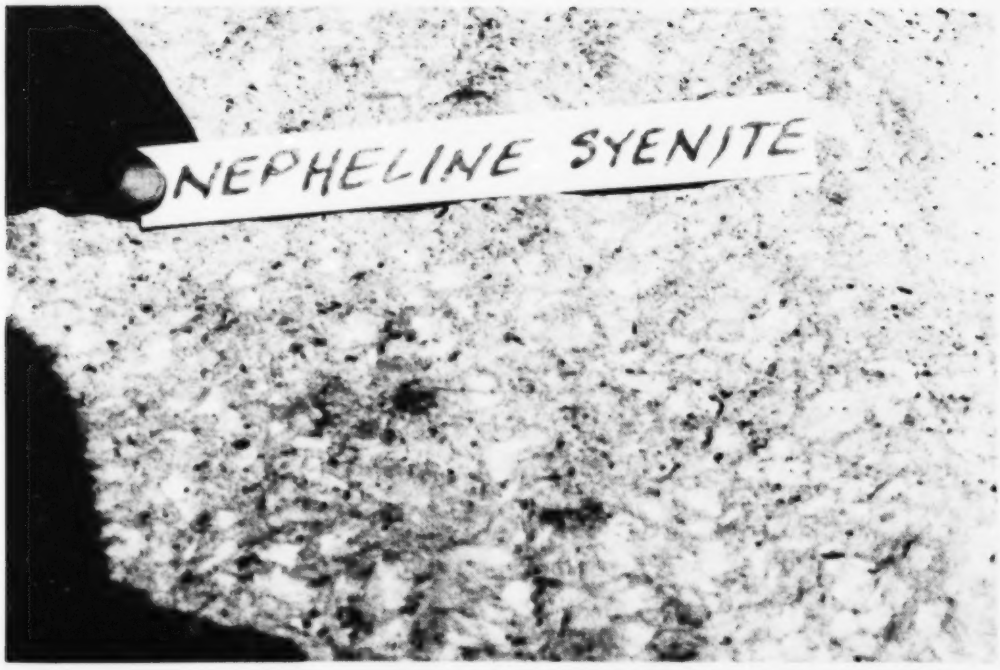



AFTER ABRASIVE BLASTING

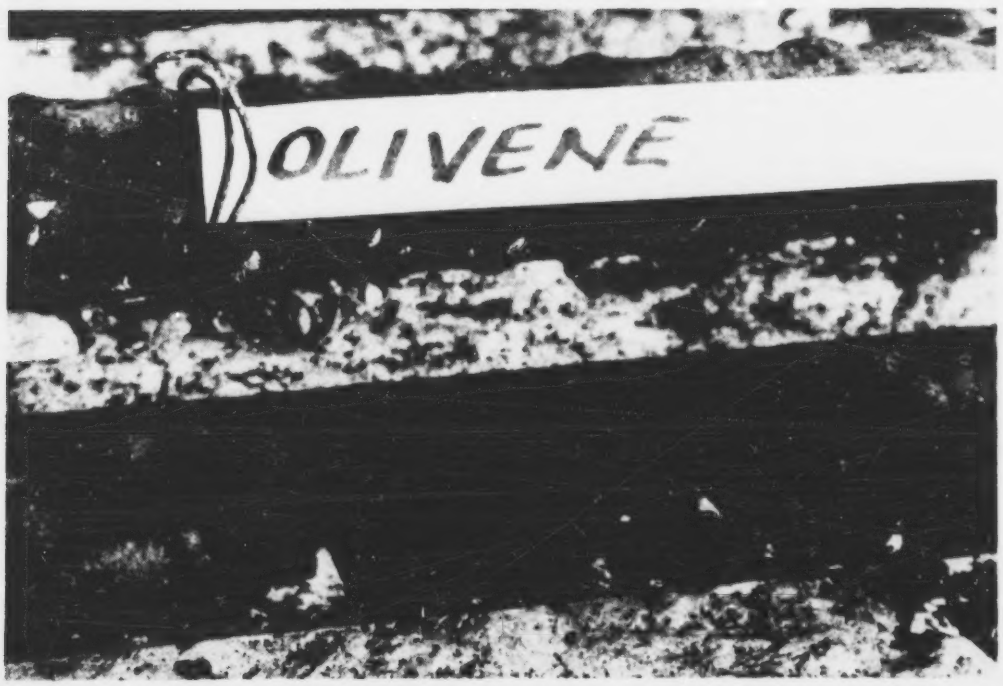
EXISTING CONDITION

AFTER ABRASIVE BLASTING

EXISTING CONDITION

AFTER ABRASIVE BLASTING

EXISTING CONDITION




**AFTER ABRASIVE BLASTING**
**(BOTTOM TWO REBARS ONLY)**

EXISTING CONDITION

AFTER ABRASIVE BLASTING

EXISTING CONDITION

AFTER ABRASIVE BLASTING